

## BATS HAPPEN—ECOLOGICALLY

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Racey, Paul A., and Susan M. Swift (eds.). 1995. **Ecology, evolution and behaviour of bats**. Oxford University Press, New York. xxi + 421 p., \$140.00, ISBN: 0-19-854945-8.

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This collection of 26 papers stems from a symposium held in February 1993 and those responsible for the published volume's rapid appearance are to be congratulated. Although the focus is on the Chiroptera, the second largest order of mammals (about 1000 species), the range of topics in the book's five sections is broad: chiropteran monophyly/diphly; fruit bats (Megachiroptera) as keystone species; reproductive biology, physiology, and energetics; ecology and physiology of Microchiroptera; and microchiropteran behaviour and ecology.

The 53 authors of the papers are a productive cross-section of active bat researchers (Europe, 25; Australia, 11; North America, 15) although Africa and the Indo-Pacific region are underrepresented (1 each) and South America and Asia are not represented. By chiropteran suborder there are 6 papers on Megachiroptera, 16 on Microchiroptera, and 4 that include aspects of both. Geographic coverage is predominantly Old World (14 papers) or inclusive (11) with only 1 paper mostly confined to New World taxa (emballonurids). Allocating the papers rather strictly to disciplines I counted the following: ecology, ten; energetics and growth, three; physiology, three; reproductive biology, three; genetics, three; activity and behavior, three; and conservation biology, one. Ecology in a broad sense is inherent in all the papers.

Ecologists, and especially those working with bats, will find plenty to digest in this beefy package and I here touch on only some of the chapters. The debate on bat monophyly ("Do the two suborders represent separate evolutionary lines? Has flight evolved twice? Are the megachiropterans more

closely related to primates than the microchiropterans?") continues and Pettigrew and Simmons are both articulate proponents of their contrasting views; as yet, no final resolution of this argument seems clear although I find the preponderance of evidence seems to favor the monophyly arguments. Some of the more provocative ecological questions concern the apparent roles of Old World fruit bats (Pteropodidae) in maintaining forests on remote islands through seed dispersal and pollination, a role all the more important because of the anthropogenic demise of much of the original avifauna that formerly served in this role. Rainey et al. suggest that the paradigm of minimal competition among tropical frugivores, originating in studies of Neotropical bats, may be inappropriate for insular pteropodids and that these bats may have a fundamental role in pollination and seed dispersal patterns. Utzurrum details the feeding ecology of nine species of fruit bats in the Phillippines; she notes that different patterns of fruit consumption between large- and small-sized bats create a heterogeneous pattern of seed scattering in the forest.

Fleming summarizes recent work with colleagues on the use of stable isotopes to study diets of bats that visit plants and, building on the work of Thomas (Thomas, D. W. 1984. Fruit intake and energy budgets of frugivorous bats. *Physiological Zoology* 57:457–467), suggests ways to assess the dependence of pteropodids on plants for both energy and protein. In comparison to pteropodids, New World fruit bats (Phyllostomidae) may obtain considerable protein from insects and be less coevolved with their food plants. That both intrinsic and extrinsic factors are important in the ecological energetics of bats is revealed in chapters by McNab and Bonaccorso (who conclude that the evolution of specialized nectarivory is usually associated with a reduction in both mass and metabolic rate and this in turn leads to a more variable body temperature) and Kunz and Stern (who found that post-

natal growth rates were inversely related to asymptotic body mass and that when the effect of body mass was removed, climate was the only variable showing a significant effect on growth rates).

Speakman provides an interesting essay on why bats are nocturnal, clearly analyzing the three obvious causes (competition with diurnal birds, avian predation, and hyperthermia) and, while concluding that hyperthermia should constrain diurnal activity of some bats, notes that none of the proposed hypotheses explain all observed features of nocturnality in bats. In a similar vein, Barclay follows up on his own earlier work and argues that although energetic demands may be the proximate constraint that reduces the number of young that can be raised (one per litter in most bats) it is calcium availability that is really critical. There is a thoughtful chapter by Fenton on how behavioral flexibility helps ameliorate certain constraints on bat performance as predators and, intriguingly, how predators on bats show some of the same constraints and flexibility. Arlettaz and Perrin underscore aspects of this flexibility in their study of trophic niches of mouse-eared bats (*Myotis*); their review of the bat literature produced only one paper that seemed to demonstrate definitive support for active prey selection among vespertilionid bats. There is an interesting paper by Walsh et al., who used a landscape-scale approach to test whether landscape and local habitat features influence bat activity in Britain. They surveyed 910, 1-km squares and found significant regional

differences among seven major land-class groups with the lowest bat activity levels in upland, marginal upland, and intensively farmed areas. Woodland habitats and habitats associated with water were actively selected while a variety of other features (arable land, stone walls, scrub and parkland, and grassland) were avoided.

Each chapter includes its own literature cited (I found references as recent as 1995 among them) and readers that are not well versed in the "international" literature of chiropteran ecology will find the citations a trove of information. The volume includes an index that contains scientific and (some) common names of both animals and plants as well as a comprehensive coverage of topics. I found very few misspellings or typographical errors, most tables and figures were useful adjuncts to the text, and, with an exception or two, the general quality of papers is consistently above average. The price of the book is a little expensive (at least for students) and may put the book more in the realm of a reference book rather than one for the general student of bat ecology. In any case, interested readers should obtain a copy as the book is well worth the reading.

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